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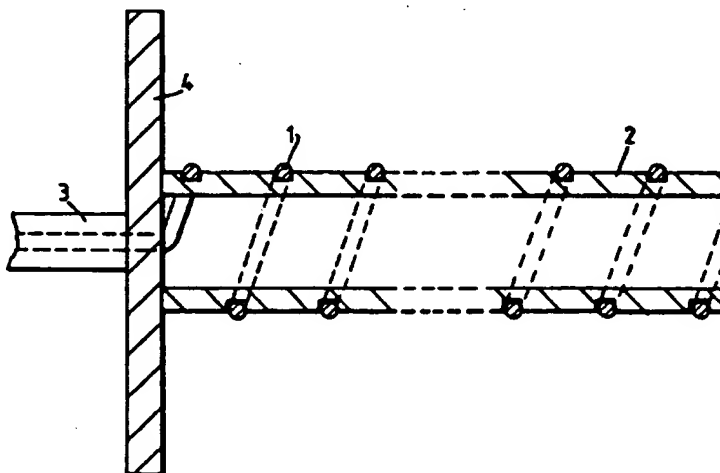
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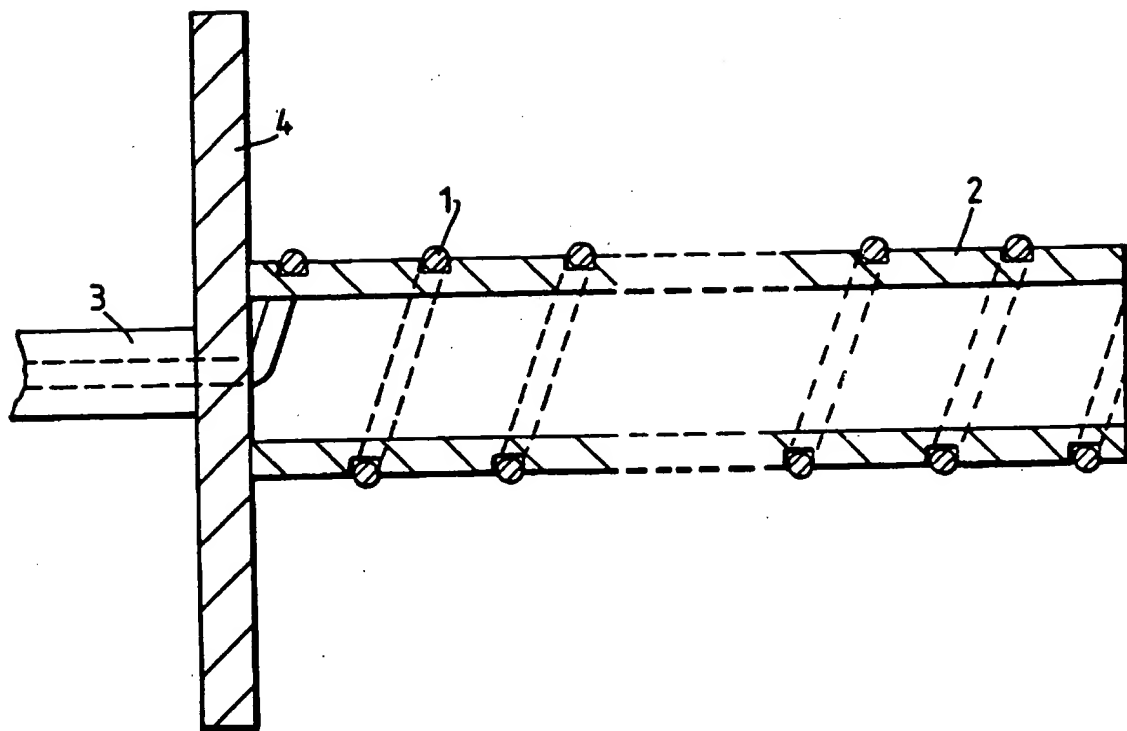(52) Domestic classification (Edition J):
H1Q DJ

(56) Documents cited
GB A 2174249 GB 1198410 GB 0980873
GB 0778518   GB 0762415 GB 0720114

(58) Field of search
H1Q
Selected US specifications from IPC sub-class
H01Q

(54) Helical antenna

(57) To match a helical antenna comprising a conductive helix (1) to a desired impedance, typically a 50-ohm feeder (3), the helix is capacitively loaded with dielectric material of suitable dimensions and dielectric constant. Suitably the helix (1) surrounds and is at least partially embedded in a dielectric tube (2). Dielectric material may be added until the antenna impedance substantially matches the desired value, for example by coating with a solution of dielectric material in a volatile solvent.

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

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DESCRIPTION:

"ANTENNA"

The invention relates to a substantially matched helical antenna, and to a method of substantially matching a helical antenna.

Helical antennas, which have been known since 1947, have well-defined characteristics and are operable over substantial bandwidths, which makes them useful for, for example, testing other antennas. The impedance of a helical antenna is generally in the range 100-150 ohms, typically 140 ohms. To match the impedance of the antenna to a desired value, typically 50 ohms, for coupling the antenna to a signal source or to a receiver, a transformer is commonly used between the antenna and a feeder which is usually a transmission line such as a coaxial line or which may be a waveguide. This has the disadvantage of requiring the use of a separate additional component; furthermore, the transformer may be relatively large at low frequencies (below 1 GHz), and difficult to realise at very high frequencies (many tens of GHz). As an alternative, the configuration of the helix itself adjacent the end from which it is fed may be adjusted to provide an impedance transformation: see for example "Measured performance of a broadband matching section for peripherally fed helical antennas" by D.E. Baker, Transactions of the South African Institute of Electrical Engineers, Vol. 76, part 2, pages 56-61 (June 1985). The accuracy of construction of such a configuration may be critical to achieving suitable impedance matching.

According to a first aspect of the invention, a helical antenna comprises a conductive helix capacitively loaded with dielectric material so that the impedance of the antenna substantially matches a desired impedance.

According to a second aspect of the invention, a method of reducing the impedance of a helical antenna comprising a conductive helix comprises capacitively loading the helix with dielectric material so that the impedance of the antenna

substantially matches a desired impedance.

Suitably, the helix surrounds and is at least partially embedded in a tube of dielectric material.

The method may comprise adding dielectric material adjacent the helix until the antenna impedance substantially matches the desired value.

It is known from GB 720 114 and GB 762 415 that the helix of a helical antenna may surround, and may furthermore be surrounded by, dielectric material. In both those patent specifications, the dielectric material was provided to support the helix. The possibility of additionally using the dielectric material favourably to influence the impedance of the antenna was apparently not appreciated: GB 720 114 refers to the use of a matching section so as to present the correct impedance to the coaxial feed cable from the transmitter or receiver, and GB 762 415, in which the helix is fed from a waveguide via a probe, disloses a movable piston located at one end of the guide in order to facilitate impedance matching of the probe from the helix into the guide.

The invention provides the advantage that the presence of a dielectric tube may in any case be desirable to support the helix, particularly for an antenna for operation at a frequency of several GHz or more. However, rather than using a material of low dielectric constant (such as Styrofoam or PVC each referred to in the above-mentioned paper by D.E. Baker), a tube may be used of sufficiently high dielectric constant and sufficient thickness so as also to reduce the antenna impedance to a desired value.

The capacitive loading provided by the dielectric material is greatest if the material is immediately adjacent the helix; adding further material at a greater distance provides progressively less additional loading. It is therefore desirable that the material should be of sufficient thickness to provide adequate capacitive loading, but not such as might result in undesired modes being excited; for example, a helix surrounding a

rod of dielectric material might also tend to act as a dielectric
rod antenna. A material of suitable dielectric constant may be
selected bearing this in mind. A dielectric constant in the
range of 2-4 may for example·be suitable for an antenna operating
at around 10 GHz. Using a material of given dielectric constant,
the quantity of material required, as measured in terms of
wavelength, remains constant with frequency, and hence in
absolute terms, its dimensions decrease with increasing
frequency.

        An embodiment of the invention will now be described, by way
of example, with reference to the diagrammatic drawing, the sole
Figure of which is a side view, mainly in cross-section, of a
helical antenna embodying the invention. The cross-section is
taken in a plane including the axis of the antenna. The antenna,
intended for operation at frequencies around, for example,
10 GHz, comprises a conductive wire most of which is wound in the
form of a helix around a circular cylindrical tube 2 of
dielectric material. The helix is axially fed at one end by a
coaxial line feeder 3 (depicted schematically), the wire 1 for
this purpose passing through an aperture (not shown) in the wall
of the tube 2 and being connected to the centre conductor of the
feeder line 3. (The helix may alternatively be fed
peripherally.) The centre conductor of the coaxial line passes
through a conductive circular disc 4 to which the outer conductor
of the line is connected so that the disc forms a ground plane
for the helix.

        The proximity to the helix of the dielectric material of the
tube 2 provides capacitance loading of the helix that reduces the
impedance presented by the helix. To increase the loading, the
wire 1 may be at least partially embedded in the tube 2; in this
particular embodiment, the wire was laid in a helical groove of
rectangular cross-section having a depth which was 50 % of the
diameter of the wire. Suitable loading to provide optimum
matching may be determined empirically by initially providing a
degree of loading (dependent inter alia on the depth of the

groove) that does not quite reduce the antenna impedance to the
desired value, and then increasing the loading by coating the
helix and tube with one or a succession of layers of a dielectric
solution from which the solvent evaporates to deposit dielectric
material adjacent the helix until the antenna impedance is
substantially optimised. (For simplicity, this additional
dielectric material is not shown in the drawing).

In a constructed embodiment for operation in the frequency
range 6.9-10.9 GHz, the tube 2 had an outer diameter of 9.5 mm
and an inner diameter of 6.1 mm; the tube was of polystyrene
having a dielectric constant of about 2.5. The diameter of the
conductive wire 1 was 1 mm; the wire additionally had a thin
plastics coating, being suitable for coil winding. To increase
the capacitive loading, the antenna was provided with several
successive dielectric coatings each made by immersing the helix
and dielectric tube in a viscous solution prepared by dissolving
polystyrene in a volatile organic solvent; the assembly was
removed from the solution and the solvent allowed to evaporate
from the layer of solution adhering to it. It was found that the
first coating produced the largest change, presumably owing to
the gaps between the helix and the groove in the dielectric tube
being filled. Further coatings produced small but nevertheless
progressive increases in capacitive loading. Using a feeder with
a characteristic impedance of 50 ohms, the VSWR of the antenna
did not exceed 1.6 over its operating frequency range and was
better than 1.5 over most of the range. It is believed that
these figures could be improved upon by providing a dissipative
load at the free end of the antenna, for example a resistive
termination of the helix or lossy dielectric material in that
region.

CLAIMS:

1.   A helical antenna comprising a conductive helix
capacitively loaded with dielectric material so that the
impedance of the antenna substantially matches a desired
5   impedance.

2.   An antenna as claimed in Claim 1 wherein the helix
surrounds and is at least partially embedded in a tube of
dielectric material.

3.   An antenna as claimed in Claim 1 or 2 in combination
10   with a feeder transmission line or waveguide, wherein the
impedance of the antenna substantially matches the characteristic
impedance of the feeder.

4.   A method of reducing the impedance of a helical antenna
which comprises a conductive helix, the method comprising
15   capacitively loading the helix with dielectric material so that
the impedance of the antenna substantially matches a desired
impedance.

5.   A method as claimed in Claim 4 which comprises adding
dielectric material adjacent the helix until the impedance of the
20   antenna substantially matches the desired impedance.

6.   A matched helical antenna substantially as herein
described with reference to the drawing.

7.   A method of matching a helical antenna substantially as
herein described with reference to the drawing.

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